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USSR'S TE-1 DIESEL-ELECTRIC LOCOMOTIVE

The Soviet government and the Communist Party have presented the introduction of diesel traction as one of the most important tasks of transport development in the postwar Five-Year Plan. To fulfill this task, the Kharkov Plant organized in record time the serial construction of the TE-1 diesel-electric locomotive, in conjunction with the electrical industry. Series TE-1 diesels are being used in passenger and freight service, and can also be used in switching service.

To obtain the data on traction and technical characteristics of the locomotive, detailed tests were carried out in the "Dinamo" Plant imeni Kirov and the Kharkov Electromechanical Plant imeni Stalin, and also on a testing ring.

A peculiarity of the TE-1 locomotive is the automatic changing of the rate of work of the power plant and the speed of movement in conformance with the track grade. The engineer's control lever is used to change the number of revolutions of the power plant. This lever has nine fixed positions, of which one corresponds to the idling speed of the diesel engine and the rest are used when the locomotive is operating under load. Each position corresponds to a definite number of revolutions, as follows:

Position	I	II	III	IV	V	VI	VII	VIII
Rpm	270±15	355±10	430±10	495±10	555±10	615±10	675±8	740±5

To obtain the widest range of change of tractive forces and speed, the TE-1 locomotive uses automatic control of the traction motors' connection and one stage of field shunting. Depending on the speed of movement, the traction motors are connected, either all in series, or series-parallel (three motors in each group), or series-parallel with shunting of the field. Starting and acceleration of the locomotive are done with series connection. At a speed of 9-11 kilometers per hour, the connection is automatically changed to series-parallel.

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When the speed reaches 20-25 kilometers per hour, field shunting is automatically cut in. When the speed drops to 19-21 kilometers per hour, the field shunting automatically cuts out. Changing the connection from series-parallel to series can be done by placing the engineer's control lever in idling position or by manual throwing of the changeover switch from series-parallel connection to series.

To protect the main generator from overload, an overload relay is installed in the locomotive. This relay is included in the circuit of the second group of motors and operates only during series-parallel operation. A wheel-slip indicator relay is installed on each truck.

Basic Specifications of the TE-1 Diesel-Electric Locomotive

Series	TE-1
Wheel arrangement	0-6-6-0
Length inside knuckles	18,892 mm
Distance between truck centers	9,450 mm
Max height	4,251 mm
Max width	3,121 mm
Wheel base	
Truck	3,430 mm
Locomotive, total	11,890 mm
Light weight	115.6 t
Weight with full supply of fuel, lubricants, and sand	123,9 t
Average weight on axle	20.65 t
Min radius curvature	125 m
Min distance between head of rail and transmission housing	104 mm
Wheel dia	1,014 mm
Max speed	90 km/hr
Transmission	Electrical
Control	Automatic

Diesel Engine and Radiator for TE-1 Locomotive

Make	D-50
Type	Four-cycle, solid-injection, with low pressure feed, 6 cylinder
Bore	318 mm
Stroke	330 mm
Working displacement of all cylinders	157.2 liters
Max working, rpm	740 (plus or minus 5)
Min working, rpm	270 (plus or minus 15)
No of positions of engineer's control lever (changing number of rpm)	8 control is effected hydraulically
Horsepower at 740 rpm	1,000
Rotation of drive shaft	Counterclockwise (viewed from side of main generator)
Governor	Centrifugal
Starter	Electrical
Fuel pump	Variable-stroke (6-piston)
Firing order of cylinders	1, 3, 5, 6, 4, 2 (viewed from engineer's seat)
Angle of spray cone	25-29 deg
Compression ratio with a clearance of 4.5-5 mm between the surface of the cylinder head and the upper edge of the piston	11.8-12.5

Spray valve	Spring loaded
Tension of spray valve spring	270-280 kg/sq cm

The fan is put in motion by the diesel's main shaft with the aid of a V-belt drive. The driving and driven shafts of the fan are connected by a friction clutch.

Coef of heat transfer of water radiator	41.5 kcal/sq m/hr/deg C
Coef of heat transfer of lubricating oil cooler	20/kcal/sq m/hr/deg C
Power required by fan at 740 rpm of main diesel shaft	42 hp
Type of fan	Helical, bladed
Fuel filter	Edge-type and cloth (felt)-type in one unit
Oil filter	Two-step, edge-type
Auxiliary fuel pump	Gear-driven from a motor
Maximum rpm of pump shaft	1,740
Capacity of motor	0.2 kw
Productivity	12.5 liters/min

Turbosupercharger

Type	Gas
Productivity (according to technical conditions)	5,100 cu m/hr
Blowing pressure (according to technical conditions)	0.22-0.34 kg/sq cm
Working temp of exhaust gases in the diesel cylinders	425-475 deg C
Temp of exhaust gases in the collectors in front of the turbine	480-550 deg C
Working rpm	Up to 10,300
Max rpm	13,000
Min rpm	1,600-2,200
Normal fuel pressure at fuel pump intake	2.5 kg/sq cm
Water Pump	Centrifugal, driven from diesel main drive shaft through gears
Ratio of water pump rpm to diesel rpm	2.4:1
Delivery of water pump at 740 rpm of diesel drive shaft (according to technical conditions)	80 cu m/hr
Working temp of engine cooling water	65-70 deg C
Max permissible water temp	85 deg C
Min permissible water temp	40 deg C
Oil pump	Gear-driven from main drive shaft through a pair of conical gears
Ratio of oil pump rmp to diesel rpm	2.266:1
Delivery of fuel pump at 740 rpm of diesel drive shaft and oil temp of 65 deg C	16,000 l/hr
Radiator sections	With flat (chamber type), corrugated tubes
No of water cooling sections	21
No of sections for cooling lubricating oil	5

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Air-cooled surface of radiator (according to design)	429 sq m
Surface of lubricating oil radiator (according to design)	94 sq m
Revolutions of radiator fan at 740 rpm of main shaft of diesel	1,240 rpm

Electrical Transmission (Main Generator)

Type	MPT-84/39
Rated capacity at 740 rpm of main shaft of diesel	620 kw
Max voltage	900
Continuous rating at 740 rpm of diesel and with temp of outside air of 40 deg C	1,150 amp
Continuous rating with temp of outside air of 25 deg C	1,250 amp
Hr rating with temp of outside air of 40 deg C	1,500
Hr rating with temp of outside air of 25 deg C	1,600

The generator is self-ventilating and the excitation is independent. The rotor shaft is connected rigidly to the engine shaft.

Combination Auxiliary Generator Exciter

Type	MVG-25/11, MVT-25/9
Rated capacity of exciter	3.6 kw
Working voltage	55 v
Max voltage	75 v
Working current	65 amp
Rpm when rpm of diesel shaft is 740	1,776

The shaft of the unit is put into motion by the shaft of the main generator by means of a V-belt drive. The unit is self-ventilating.

Exciting	Compound
Rated capacity of auxiliary generator	5 kw
Voltage	76 v
Current	66 amp
Generator is self-exciting	
Voltage regulator of auxiliary generator	Vibration type, SRN-2

The shaft of the unit is driven from the main shaft of the diesel with a V-belt drive.

Electric Traction Motor

Type	DK-304B
Continuous rating with temp of outside air of 25 deg C	725 amp
Hr rating with temp of outside air of 25 deg C	840 amp
Continuous rating with temp of outside air of 40 deg C	680 amp
Hr rating with temp of outside air of 40 deg C	770 amp
Shunting of motor field	35 %

Ventilation	Forced
Type of ventilator	Sirocco
Rpm of ventilators of 740 rpm of diesel shaft	2,160 rpm
Delivery of air to each traction motor when engineer's control lever is in 8th position	25 cu m/min
Exciting	Series
No of traction motors	6
Drive	Axle-hung, nose-suspended, single reduction gear with straight teeth
Gear ratio	75:16 - 4.6875
Maximum rpm of traction motor drive shaft	2,200
Connection when starting and accelerating to 10 km/hr	Series
Basic running connection	Series-parallel, and series-parallel with shunting of motor field

Storage Battery

Type	TN-550; lead, acid
No of elements	32
Capacity	550 amp-hr
Voltage	64 v
Terminal charging current	25 amp
Voltage of elements (after charging)	2.34 v
Max charging current (quick charge)	1,700 amp

Air Compressor

Type	3-SB
Stages of compression	2
No of cylinders	3 (2 low-pressure, 1 high-pressure)
Stroke	142.9 mm
Bore of low-pressure cylinders	196.85 mm
Bore of high-pressure cylinders	139.7 mm
Pressure at first stage of compression	From 4 to 4.9 atm
Max possible rpm	800
Min working rpm	250
Productivity at 250 rpm	2.2 cu m/min
Productivity at 740 rpm	5.5 cu m/min

Continuous operation at full pressure is permitted at 400 rpm (3d position of engineer's control lever)

Productivity of compressor at 400 rpm	3.5 cu m/min
Power required under load at 250 rpm	15.0 hp
Power required at 740 rpm	46 hp

Cooling of the air between stages of compression in the corrugated radiator is natural

Power Expended for Auxiliary Equipment at 740 rpm of Diesel

Compressor	46 hp
Radiator fan	42 hp
Traction motors' cooling fan	2 x 4 - 8 hp
Auxiliary generator-exciter	9-13 hp
Cab heater (at 2,500 rpm, 76 v)	0.03 kw
Electric motor of auxiliary fuel pump (at 1,740 rpm) 76 v	0.2 kw

Brakes

TE-1 diesel locomotives are equipped with hand brakes, automatic air brakes, and auxiliary air brakes.

Brake valve	Matrosov system (2)
Engineer's brake valve	Kazantsev system
Braking	Single-stage

The brake is equipped with a device for operation when the locomotive is in multiple-unit operation.

Weight of Separate Parts of Locomotive

Engine with generator and turbo-supercharger	20,500 kg
Engine alone	15,380 kg
Turbosupercharger	920 kg
Cylinder cover with valves and spray valve	192 kg
Piston with connecting rod and bearings	149 kg
Cylinder liner	118.2 kg
Engine block with camshaft	2,960 kg
Engine frame with bearings and oil bath	4,480 kg
Crankshaft	1,780 kg
Main generator	4,200 kg
Auxiliary generator-exciter	385 kg
Traction motor	2,430 kg
Wheel pair with gear (wheel dia 1,014 mm)	2,080 kg
Locomotive frame	21,050 kg
Truck frame	4,615 kg
Truck with motors and wheel pairs	23,850 kg
Hood over engine	1,732.2 kg
Air compressor	606 kg

Fuel and Water Supply, etc.

Water in engine cooling system	945 liters
Oil in crankcase of the diesel	348 liters
Fuel	
Total:	6,050 liters
In upper tank:	3,250 liters
In lower tank:	2,800 liters
Lowest dead fuel reserve when operating on level track	150 liters
Sand in sandboxes	1 cu m (1,150-1,400 kg)
Lubricants for equipment	50 liters

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